Predicting Hearing Health Readiness as a Function of the Army Profile System Formula and Occupational Safety and Health Administration Reportable Hearing Loss

Major Wayne R. Smetana

U.S. Army-Baylor University Graduate Program in Healthcare Administration

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14. ABSTRACT
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Abstract

A standardized process of determining the hearing health readiness of personnel in uniform does not exist across the services in the Military Health System, (MHS). This study examines the interchangeability between the Occupational Safety and Health Administration (OSHA) Reportable Hearing Loss (ORL) and the U.S. Army's H-3 and H-4 profile formula. The Army employs a specific formula for determining the profiling measures for uniform personnel (AR 40-501, 1995). The Air Force also uses a published standard for identifying fitness (United States Air Force Instruction 48-123, 1997). The U.S. Navy and Marine Corps use publications outlining the management of their Hearing Conservation/Industrial Audiology programs, U.S. Navy Instruction 5100.19C Forces Afloat and U.S. Navy Instruction 5100.19D Forces Ashore. These publications do not present criteria for evaluating the readiness of their uniform personnel using a classification system. If interchangeability exists between the ORL and Army's standards, this method may be applied across the Department of Defense to evaluate the hearing health readiness for uniform personnel.

Introduction

Conditions Which Prompted the Study

A uniform system for analyzing the hearing health readiness of personnel across the United States Army, Air Force, Navy and Marines Corps does not exist in the Department of Defense (DoD). The Downsizing of DoD and the Military Healthcare System creates the need for increased efficiency in evaluating the health readiness of those uniform service members. Interchangeability between OSHA Reportable Hearing Loss (ORL), and the profile standards used by the Army can create an effective method for analyzing the readiness of military personnel. It also creates a process by which the Navy and Marine Corps can predict the readiness of their forces.

Protecting the hearing acuity of our uniform personnel as they train for the battlefield is an important component of readiness. "A soldier's ability to hear low-intensity sounds or speech is critical to soldier readiness and survivability" (Ohlin, 1998, p. 51). Force protection contributes to avoiding costs incurred by replacing individuals who may no longer be physically capable of performing their trained skills. Ohlin (1998) states that reductions in hearing loss among combat arms personnel in the Army between 1974 and 1994 saved $504,309,362. That savings is realized by avoiding the need to train new personnel to replace individuals no longer effective due to a debilitating hearing loss.

For over twenty years the United States Army has managed a comprehensive hearing conservation program (HCP) to reduce the prevalence of noise induced hearing loss (NIHL) in military personnel. As a part of the Army program, personnel demographics and hearing threshold levels (HTL) are captured and stored in a centralized data registry system called the Hearing Evaluation Automated Registry System (HEARS). Besides recording HTL data, the

HEARS has the capability to calculate the profile status of each individual receiving a hearing test.

A more thorough understanding of the profiling system is needed before analysis of this management problem can be presented. The physical profile serial system is based upon the function of body systems and their relation to military duties. The functions of the various organs, systems, and integral parts of the body are considered. In this system, the functions are considered under six factors designated "P-U-L-H-E-S" (See Appendix A). Four different numerical categories are used to reflect different levels of functional capacity. The purpose of the profile serial is to provide an index to overall functional capacity of the organ or system not specifically the defect. Those four numerical designations for determining hearing capacity are H-1, H-2, H-3, and H-4 (Army Regulation 40-501, 1995).

Profiling describes the functional hearing ability of Army personnel in relation to performing military duties (Army Regulation 40-501, 1995). This study focuses on the hearing profile designator "H-3" (GH-2), which presents a picture of the individual's ability to perform certain functions efficiently and safely. For the purposes of this paper, H-3 will be referred to as "GH-2" as it will include the profile category "H-4" within its calculations.

An individual having a numerical designation of "1" under all factors is considered to possess a high level of medical fitness. A designator of "2" under any or all factors indicates that an individual may possess a medical condition or physical defect requiring physical activity limitations. A profile containing one or more designators of "3" signifies that the individual has one or more medical conditions or physical defects causing significant limitations. The individual should receive assignments commensurate with his or her physical capability for military duty. A profile serial with one or more numerical designators of "4" indicates that the individual has one or more medical conditions or physical defects of such severity that performance of military duty must be drastically limited (Army Regulation 40-501, 1995). The "4" indicates there are significant limitations, which must be fully described if such an individual is returned to duty. Any designator of a GH-2 requires a medical review board to determine fitness for duty. The formulas for calculating hearing profile status are presented in Appendix B (Army Regulation 40-501, 1995).

The Occupation Health and Safety Administration also has a formula for calculating ORL. ORL is defined as a change in hearing threshold level relative to the original baseline audiogram of an average of 25dB or more, averaged over 2000, 3000, and 4000 Hertz (kHz) in either ear from the original reference audiogram. The report is required only once. No age corrections will be applied in these calculations (OTSG, 1994). The hearing loss in the same individual is again reported when an additional 25dB or more hearing loss is measured in the same ear when compared with the thresholds of the audiogram that identified the first reportable hearing loss (OTSG, 1994). The formula for calculating ORL is represented in Appendix C. (OTSG, 1994)

If a significant interchangeability exists between ORL and Army GH-2 and greater profiles, the Navy and Marine Corps could utilize this system to predict the hearing health readiness of its personnel in uniform. This method presents a method of predicting a potentially limiting factor of the physical ability of uniform personnel to perform combat and combat related tasks within an operational environment.

The focus of this management project is to statistically analyze data fields from records captured during calendar year 1997. These records are stored within the HEARS database located at the Defense Occupational Health Readiness System (DOHRS) data warehouse at the

U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), Aberdeen Proving Ground, MD. The purpose of analyzing this data is to determine if interchangeability between ORL criteria and GH-2 formulas for hearing loss profile exists. The primary variables to be studied in this project are as follows: (X_1) = OSHA formula for reportable hearing loss and (X_2) = Army formula for GH-2 profiles.

Statement of the Problem

The purpose of this study is to determine if the Army profiling criteria and ORL criteria are essentially similar by comparing the results of the two separate calculations from hearing threshold data. The U.S. Army uses profiling criteria for determining the ability of personnel to perform military duties as a function of their hearing ability. The U.S. Air Force uses criteria that are different from the Army. The U.S. Navy and Marine Corps do not employ a formula to determine readiness of their personnel. As the MHS continues to look at avenues to save costs, using one standard throughout the DoD streamlines the medical evaluation process. One process used by all services as a standard measure of readiness reduces the need for redundancy in the provision of healthcare. Savings could be realized by increasing the horizontal integration of hearing healthcare delivery across the services. If an interchangeability exists between the Army's GH-2 profile standard and the OSHA formula for calculating ORL, then that standard can be applied to the Army's data in determining hearing health readiness of soldiers. Those individuals whose acuity places them in the GH-2 category would also be identified using the ORL formula.

The ORL formula is the national standard used for determining occupational illness thoughout industry. The Department of Labor Code of Federal Regulations (OSHA, 1989), requires by law that formula applies to civil service employees who are enrolled in the HCP

(OSHA). Streamlining the system could save personnel costs in simplifying the management of HCPs in the DoD.

Literature Review

Several articles report studies surrounding DoD military and civilian personnel in hearing conservation programs include Cain (1998), Adera, Donahue, Malit, & Gaydos, (1993, 1997); Pelausa, Abel, Simard & Dempsey, (1995); Henselman, Henderson, Shadoan, Subramaniam, Sauders & Ohlin, (1995); and Wolgemuth and Luttrell, (1995). No literature could be found examining interchangeability between OSHA reportable hearing loss and the Army GH-2 profile formulas. U.S. Naval personnel (Wolgemuth and Luttrell, 1995), the Canadian Military (Pelausa, et al., 1995), and U.S. Army personnel, (Henselman, et al. 1995) reviewed the frequency and significance of hearing loss within their personnel as a method to evaluate program performance. Henselman, et al. (1995) also used hearing threshold data to compare hearing loss between populations representing different demographic groups. These studies did not examine the data for interchangeability between OSHA reportable hearing loss and standards addressing physical limitations that reduce military occupational skill performance. Their findings revealed black soldiers consistently had the most sensitive hearing as averaged across exposure groups and years of service. The acuity of white soldiers as averaged across the exposure groups did suggest poorer acuity. In this study, if interchangeability does not exist between ORL and the GH-2 profile formula, examining the demographic data in two separate modalities will discover if commonalties exist in those individual cases.

Simpson, et al. (1994) reviewed audiometric data from 21 HCPs to determine the quality of HCP performance base upon audiometric test variations. Adera, et al. (1993) examined a cohort of 599 workers exposed to hazardous noise to develop a risk ratio for the potential of suffering from noise induced hearing loss as an alternative to other methods of evaluating a HCP. Adera, et al. (1997) conducted statistical evaluations of 22 populations of noise exposed workers from industry to determine which may be suited as a comparison group for future studies of workers exposed to hazardous noise. Cain (1998) discussed the profiling modality used by the army in conjunction with NIHL and the confounding effects of presbacusis.

Purpose of the Study

This study examines the HEARS data to determine if interchangeability exists between OSHA reportable hearing loss and the profile formula for GH-2 hearing loss. Two hypotheses were examined to determine if ORL and GH-2 are interchangeable. The first used a McNemar's test to determine if the proportion of people classified with GH-2 and ORL were the same. The second used a Kappa statistic to measure the degree of agreement between ORL and GH-2.

Methods and Procedures

Subjects: Department of the Army service members routinely exposed to hazardous levels of noise and enrolled in the HCP. This data is stored in the DOHRS Data Warehouse located at the USACHPPM. This data set encompasses audiometric data from soldiers throughout the Army since 1982 and are recorded and archived using the HEARS system. This system provides audiometric surveillance information, which is intended to accomplish early detection of noise, induced hearing loss (NIHL) and other health disorders affecting hearing.

The McNemar's test compares the proportions of people with a "hearing classification" (ORL or GH-2). The hypotheses for this study are shown in Table 1.

Table 1.

Null Hypothesis

H_o: The proportion of persons classified with a hearing profile is the same for ORL and GH-2 (Equally effective for prediction).

Alternate Hypothesis

H_a: The proportion of persons classified with a hearing profile is not the same for ORL and GH-2 (Not equally effective for prediction).

A Kappa statistic is the second method used to assess the purpose of this study. It is used as a measure of agreement between The ORL and GH-2. The hypothesis for this study is shown in Table 2.

Table 2.

Null Hypothesis

H_o: The Kappa statistic measuring agreement between ORL and GH-2 is = 0 implying no agreement.

Alternate Hypothesis

H_a: The Kappa statistic measuring agreement between ORL and GH-2 is ≠ 0 implying some agreement.

Design: This is a retrospective descriptive study utilizing elemental audiometric data from USACHPPM from calendar year 1997. There are 192,751 records available from 1997 to be recalled for this study. Of those records, 82,615 meet the analysis criteria for ORL and are used in this study. Definitions of demographics included in the data set are shown in Appendix D. This study will examine the data from 1997 as it presents the most current sample of personnel in uniform today. The availability of additional data from 1987 to 1994 creates a platform for rapid analysis of those data sets should additional studies become desirable. The same records meeting the ORL criteria are used as the population for GH-2 comparison. Of those records identified as demonstrating a GH-2 profile, fifty were randomly selected by computer query and manually analyzed for the accuracy of the classification. All fifty records were correctly identified as GH-2 as described in AR 40-501.

Analysis

The statistical analysis for this study will be performed using the SPSS (Statistical Package for Social Sciences), version 9.0. Subject profile data was coded into three different categories with the focus placed on non-parametric analysis and agreement statistics. Three primary comparisons were made: (1) GH-2 and ORL, (2) H-2 and ORL, (3) GH-2 plus H-2 and ORL. A McNemar's test was used to determine if the proportion of personnel using the Army formulae for calculating a hearing loss profile is the same as the proportion showing ORL. Table 3 presents a sample matrix of the McNemar's test (Zar, 1996).

Table 3

McNemar's 2x2 Table

		Military Profile GH-2	
		NO GH-2	YES GH-2
OSHA Reportable Hearing Loss	No	**Agree**	**Disagree**
	Yes	**Disagree**	**Agree**

Four additional comparisons of gender with the total population sample were made: (1) Females with profiles and ORL, (2) Males with profiles and ORL. (3) Age groups <20, 20-24, 25-29, 30-39, >40 with profiles and ORL. These groups are categorized in this study as age group “20”, “24”, “29”, “34”, “39”, and “40”. (4) Age groups by gender, profile status, and ORL.

Using this design the interchangeability will be examined between the variables, ORL formula and the Army profile formula. A Kappa test was employed to examine the degree of agreement between ORL and profile variables.

The records examined in this study were downloaded in a format compatible with SPSS version 9.0. The ORL formula requires the earliest dated reference audiogram, the DD2215 Baseline Hearing Test record, compared to the annual surveillance audiogram the DD2216 Annual Hearing Test with a test date of 1997. To analyze profile data over a consistent population with ORL, only those records possessing both a DD2215 and DD2216 were considered in this study. The total population (n) included in this analysis comprised 82,615 military personnel with both a DD2215 and DD2216 hearing test.

The population of the Army is not static and changes occur as personnel leave the service at the end of their tour of duty or retirement. Capturing the data from the last calendar year presents the most accurate portrayal of hearing acuity of current personnel on active duty today. The latest year of data available for study is 1997.

Psychometrics:

The audiometric elemental data is derived from pure-tone air conduction HTL from U.S. Army soldiers exposed to hazardous levels of noise. Portions of the data are also captured from periodic physical examinations. These hearing tests are conducted using a Tracor RA 600AM microprocessor audiometer, in a certified sound treated environment capable of testing one to eight individuals at a time. The equipment determined HTLs using the modified Hughson-Westlake ascending method (Carhart & Jerger, 1959). During the testing the HEARS audiometer automatically (1) tested the left ear first; (2) began testing at 0dB at 1 kHz; (3) tested frequencies in the sequence of 1, 2, 3, 4, 6, 1 (retest), and 0.5 kHz; and (4) presented pure-tone stimuli as pulsed rather than continuous tones (Henselman et al., 1995). Audiologists or other medical personnel who received forty hours of training to obtain certification in hearing testing procedures administered all hearing tests. Instructors certified through the Council for the Accreditation of Occupational Hearing Conservationists conducted those training courses.

Ethical Considerations

These data are aggregate without names of individual persons attached to the records. Personal demographic data as well as hearing test results are included in the data sets. Social Security numbers are encrypted to ensure security of privacy act information. These data cannot be traced to specific individuals.

Findings

The McNemar 2x2 tables are utilized to analyze this data from four different perspectives as seen in Appendix E. There are a total of 82,615 records meeting the requirements for examination in this study. Of that population (n) of records only 2,132 present a GH-2 profile. Of those records presenting the GH-2 profile, only 1020 (47.8%) also possess an ORL according to the OSHA formula ($p < .001$), which is significantly less than the 100% expected for interchangeability between GH-2 and ORL. The Kappa statistic for a measure of agreement between classification methods is .382, which is significantly different from 0 implying agreement exists between the two classification measures (p = .001). However, A Kappa statistic of less than .40 suggests poor agreement between these two methods (Fleiss, 1981).

An examination of the demographic gender "female" revealed seventy-two cases of GH-2 profile out of 8,530 records. Of those cases, 36 (50.0%) also demonstrated a positive ORL (p <.01). The gender "male" comprised 74,085 records of which 2,060 demonstrated a GH-2 profile. Of those records, only 984 (47.8%) had both the GH-2 and ORL (p <.001).

The H-2 profile category alone presented 4,950 records with an H-2 profile. Of those records only 1,339 (27.1%) also present ORL (p <.001) which is significantly less than the 100% expected for interchangeability between GH-2 and ORL. The Kappa statistic for measure of agreement between classification methods reveals a value of .307 (p = .001), which is less than .40.

Of the 82,615 total records, 7,082 presented an H-2 + GH-2 profile combined. Within that data set, 2,359 (33.3%) also demonstrate ORL (p <.001) significantly less than the 100% expected. The Kappa statistic for a measure of agreement reveals a value of .441 (p <.001). A Kappa between of .40 & .75 suggests fair to good agreement, however this result is still low (Fleiss, 1981).

Appendix F displays the distribution of the ages of the population within this study. The mean age for the population is 30.7 years. The second graph displays the distribution of the population within the five age categories.

Appendix G presents age groups 20 (n=613), 24 (n=20,070), 29 (n=22,653), 34 (n=16,888), 39 (n=12,875), and 40 (n=9516). Age Group 20 presents only 13 cases of GH-2 profile of which four (30.8%) also have ORL (p = .804) significantly less than the 100% expected. Age group 24 presents 289 cases of GH-2 profiles of which 113 (39.1%) also have

ORL ($p = .747$). Age group 29 presents 297 GH-2 profiles where 115 (38.7%) also demonstrate ORL ($p = .023$). Age group 34 presents 374 GH-2 profiles with 170 (45.5%) of those records also presenting an ORL ($p < .001$). Age group 39 presents 454 GH-2 profiles with only 255 (56.7%) also demonstrating an ORL ($p < .001$). Age group 40 presents 705 GH-2 profiles of which 363 (51.5%) are ORL ($p < .001$). The Kappa scores are also listed in Appendix G. Scores for all age groups are <.40 which indicates poor agreement between those two methods (Fleiss, 1981).

Results from the study ORL, Profile GH-2, by age groups and Gender are seen on Appendix H. Age group 20 (n=613) by gender “Female” (n=96) and “Male” (n=517) presents two cases of females with a GH-2 profile. Of that group zero (0%) present an ORL ($p > .99$). Males present eleven cases of GH-2 with four (36.4%) also having an ORL ($p > .99$). Group 24 (n=20,070) by gender female (n=2,402) and male (n=17,668) present fifteen cases females demonstrating GH-2 profiles with ten (66.7%) also having ORL ($p = .143$). Males in this group presented 274 cases of GH-2 profiles with 103 (37.6%) also having an ORL ($p = .473$). Age group 29 (n=22,653) by gender female (n=2,489) and male (n=20,164), presents sixteen females with GH-2 profiles and seven (43.8) also demonstrating ORL ($p > .99$). Males present 281 GH-2 profiles of which 108 (38.4%) also present an ORL ($p = .023$). Group 34 (n=16,888) by gender female (n=1,574) and male (n=15,314) presents ten cases of females with GH-2 profiles of which only five (50%) also present an ORL ($p < .001$). Males in this group present 364 cases of GH-2 profiles of which 165 (45.3%) also present an ORL ($p < .001$).

Age group 39 (n=12,875) presents a female gender population of n=1,151. The gender male comprises n=11,724. This group presents fifteen records from females that have GH-2 profiles of which eight (53.3%) also present an ORL ($p = .189$). Males from this group present

439 GH-2 profiles of which 247 (56.3%) also have an ORL ($p < .001$). Group 40 (n=9,516) presents fourteen records from females (n=8,698) with GH-2 profiles of which only six (42.9%) also have ORL ($p = .383$). Males in this group present 691 GH-2 profiles of which 357 (51.7%) also present an ORL ($p < .001$). The significance value for age groups 20, 24, 29 (females), 39 (females), and 40 (males) were not statistically significant with $p > .05$. The Kappa results are also mixed. Groups 20, 24 (males), 29 (males), 34, 39 (males), and 40 show poor agreement between these test methods. Appendix I presents the Kappa Statistic results for these tests.

Discussion

The purpose of this study was to examine HEARS data to determine if interchangeability exists between ORL and the GH-2 profile formulas. All the profile formulas outlined in Army Regulation 40-501 as well as gender and age demographics were examined for interchangeability. Findings reveal a low percentage of interchangeability between ORL and GH-2, H-2, and GH-2 + H-2, opposed to the nearly 100% interchangeability as would be expected for ORL to be a good predictor of hearing health readiness. Examining age groups and age groups by gender did not reveal favorable interchangeability within these demographic categories.

One possible explanation for these results is the number of filters used to calculate ORL compared to the profile formula. ORL possess essentially one filter, the U.S. Army profile system has three at each designator. Another contributor to these results could be that baseline hearing tests for new personnel are recorded after initial duty in basic training and advanced individual training. Hearing tests for potential service members are conducted at military entrance processing stations during the physical examination process and are not recorded as a baseline hearing test on the HEARS system. Consequently exposure to hazardous noise occurs prior to audiometric monitoring is initiated. This exposure may result in an unaccounted for shift of hearing sensitivity resulting in a potentially higher rate of interchangeabitliy between these two measurement methods.

Conclusions and Recommendations

The findings of this study reveal that ORL is not a good predictor of hearing health readiness due to a lack of interchangeability between both ORL and profile processes. The low percentage of interchangeability between ORL and GH-2, (47.8%), H-2 (45.2%), and GH-2 + H-2 (33.3%) ($p < .001$) rejects the null hypothesis and accepts the alternative. **H_a = the proportion of persons classified with a hearing profile is not the same for ORL and GH-2, (Not equally effective for prediction).** Good interchangeability should reflect scores close to 100% for ORL to be a good predictor.

Since it is not a good predictor for the U.S. Army, this finding also indicates that ORL should not be applied across the Department of Defense. This study supports a finding that the U.S. Army should continue using the profile formulae against the elemental audiometric data instead of using ORL to estimate hearing health readiness.

The Kappa statistic as a measure of agreement <.40 also does not support a finding of agreement between both GH-2 and the H-2 category of profile. The GH-2 + H-2 present a Kappa statistic of .441 which presents a slightly higher but still less than good agreement.

Comparing GH-2 and ORL by age groups rejects the null hypothesis. Age groups 20 and 24 did not present statistically significant findings. The Kappa measure of agreement <.40 also does not support a finding of agreement between GH-2 and ORL within age groups (Fleiss, 1981).

Comparing GH-2 and ORL by age groups by gender rejects the null hypothesis. Age groups 20, 24, 29 (males), 39 (males), and 40 (females) did not present a statistically significant finding with $p > .05$.

Recording a baseline hearing test using the HEARS system upon induction into military service captures audiometric data prior to occupational exposure. Any unaccounted for changes in hearing acuity from initial military training should be examined in a future study to reevaluate ORL and profile formula interchangeability.

This finding does not rule out the possibility of the Air Force examining interchangeability of their profile formulas compared to ORL. Their process to calculate profile standards is a similar process to ORL and could be beneficial for predicting hearing health readiness within their system. This interchangeability also presents the possibility of a method of predicting Veterans Administration (VA) compensation rates. The VA currently employs a complicated, time consuming procedure for determining compensation based upon hearing loss suffered by veterans. As hearing healthcare professionals, Clinical Audiologists are required to perform those studies at a substantial cost in personnel expense. Cost savings can be realized by reducing or eliminating the requirement for a personnel intensive evaluation process. Additional studies may consider using the ORL formula against DoD civilian employee elemental audiometric data to estimate the Office of Worker's Compensation Program (OWCP) workers compensation.

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Physical Profiles Serial

	Profile Serial 1	Profile Serial 2	Profile Serial 3 (GH-2)	Profile Serial 4 (GH-2)
P - Physical Capacity or Stamina **U** - Upper Extremities **L** - Lower Extremities **H** - Hearing and Ears **E** - Eyes **S** - Psychiatric	**Deployable**	**Deployable**	**Not Deployable**	**Not Deployable**

Appendix A

Equations for Hearing LossProfiles

Equations for H-1 Profile

Eqn1 H-1 (H.5R+H1R+H2R)/3 or (H.5L+H1L+H2L)/3 <= 25 decibels (dB)

AND

Eqn2 H-1	H.5R <= 30	AND	H.5L	<= 30	AND
	H1R <= 30	AND	H1L	<= 30	AND
	H2R <= 30	AND	H2L	<= 30	AND
	H4R <= 45	AND	H4L	<= 45	

Equations for H-2 Profile

Eqn1 H-2 (H.5R+H1R+H2R)/3 AND (H.5L+H1L+H2L)/3 <= 30 decibels (dB)

AND

Eqn2 H-2	H.5R <= 35	AND	H.5L	<= 35	AND
	H1R <= 35	AND	H1L	<= 35	AND
	H2R <= 35	AND	H2L	<= 35	AND
	H4R <= 55	AND	H4L	<= 55	

OR

Eqn3 H-2 * {H.5R <= 30 AND H1R <= 25 AND H2R <= 25 AND H4R <= 35}

OR

{H.5L <= 30 AND H1L <= 25 AND H2L <= 25 AND H4L <= 35}

*Poorer ear may be deaf.

Equations for >H-2 Profile

Eqn1 >H-2 (H.5R+H1R+H2R)/3 > 30 decibels (dB)

OR

(H.5L+H1L+H2L)/3 > 30 decibels (dB)

OR

Eqn2 >H-2	H.5R > 35	OR	H.5L	> 35	OR
	H1R > 35	OR	H1L	> 35	OR
	H2R > 35	OR	H2L	> 35	OR
	H4R > 55	OR	H4L	> 55	

Eqn3 >H-2

{H.5L > 30 AND H1L > 25 AND H2L > 25 AND H4L > 35}

AND

{H.5R > 30 AND H1R > 25 AND H2R > 25 AND H4R > 35}

H.5, H1, H2, H3, and H4 signify hearing threshold levels at .5, 1, 2, 3, and 4 kHz respectively
R = Right ear
L = Left ear

OSHA Reportable Hearing Loss (ORL) Formula

[(H-2RS-H-2RI)+(H3RS-H3RI)+(H4RS-H4RI)]/3 >= 25dB

OR AS

[(H-2LS-H-2LI)+(H3LS-H3LI)+(H4LS-H4LI)]/3 >= 25dB

The following modifications to the above equations were employed to improve programming Efficiency:

[(H-2RS-H-2RI)+(H3RS-H3RI)+(H4RS-H4RI)]/3 >= 25dB

OR AS

[(H-2LS-H-2LI)+(H3LS-H3LI)+(H4LS-H4LI)]/3 >= 25dB

Where, H-2, H3, and H4 signify hearing threshold levels at 2, 3, and 4 kHz respectively
R = Right ear
L = Left ear
I = Inception test (original DD Form 2215 baseline hearing test)
S = Subsequent test, (DD Form 2216 annual hearing test)

Demographic Variable Definitions

Appendix 3

Variable	Definition
Age	Age of the military member on the most recent birthday pr the recorded test.
Gender	Gender is defined as female (0) male (1).
Race/Ethnicity	Following the current US Bureau of the Census classifications, Personnel were grouped into four racial/ethnic groups. Personnel referred to as “white,” (1) are those who are coded as “white” but “not of Hispanic/Spanish origin.” Personnel categorized as “black,” (2) are those individuals coded as “black,” but “not of Hispanic origin.” “Hispanic” (3)includes anyone of Hispanic origin – whether racially white, black, or other. The category “other” (4) consists all other persons not elsewhere classified.
Military Occupational Specialty (MOS)	The job skill identifier indicating which occupation the individual Is trained to perform duties. (designated by Army Regulation 611-201, 1988 and the Defense Manpower Data Center [DMDC]).
DCCODE	Department of Defense Component
SCCODE	Service Code - R = Regular Army
UIC	Alpha Numeric Identification Code for U.S. Army installation

Appendix D

ORL * Profile Analysis Tables

ORL * PROFILE GH-2

			PROFILE GH-2 N	PROFILE GH-2 Y	Total
ORL	**N**	Count	78,541	1,112	79,653
	Y	Count	1,942	**1,020**	**2,962**
		% within GH-2	2.4%	**47.8%**	1.8%
	Total	Count	80,483	**2,132**	82,615
		Exact Significance	p <.001		
		Kappa	0.382		

ORL * PROFILE GH-2 * Gender

Gender	**ORL**		PROFILE GH-2 N	PROFILE GH-2 Y	Total
F	**N**	Count	8,385	36	8,421
	Y	Count	73	**36**	**109**
		% within GH-2	0.9%	**50.0%**	1.3%
	Total	Count	8,458	**72**	8,530
M	**N**	Count	70,156	1,076	71,232
	Y	Count	1,869	**984**	**2,853**
		% within GH-2	2.6%	**47.8%**	3.9%
	Total	Count	72,025	**2,060**	74,085
	F	Exact Significance	p = .001		
	M	Exact Significance	p <.001		

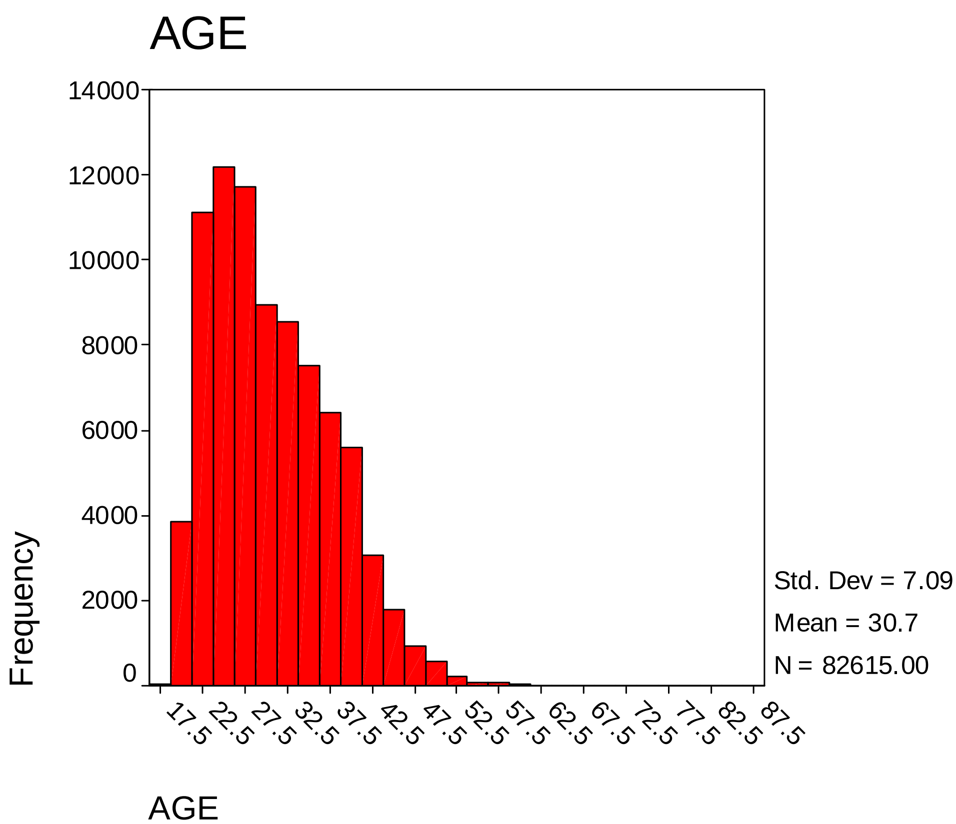
ORL * PROFILE H-2

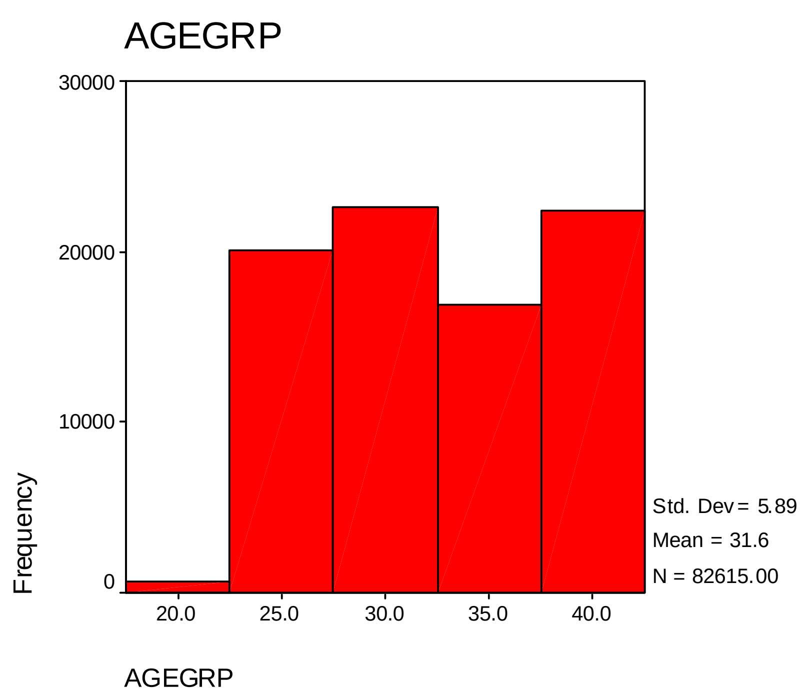
			PROFILE H-2 N	PROFILE H-2 Y	Total
ORL	**N**	Count	76,042	3,611	79,653
	Y	Count	1,623	**1,339**	**2,962**
		% within H-2	2.1%	**27.1%**	3.6%
	Total	Count	77,665	**4,950**	82,615
		Exact Significance	p <.001		
		Kappa	0.307		

ORL * PROFILE GH-2 + H-2

			PROFILE H-2 N	PROFILE H-2 Y	Total
ORL	**N**	Count	74,930	4,723	79,653
	Y	Count	603	**2,359**	**2,962**
		% within GH-2 + H-2	0.8%	**33.3%**	3.6%
	Total	Count	75,533	**7,082**	82,615
		Exact Significance	p <.001		
		Kappa	0.441		

Age Group Distribution





ORL * Profiles by Age Group

AGE GROUP				PROFILE GH-2 N	PROFILE GH-2 Y	Total
20	ORL	**N**	Count	593	9	602
		Y	Count	7	**4**	**11**
			% within PROFILE GH-2	1.2%	**30.8%**	1.8%
	Total	=	Count	600	**13**	613
Exact Significance	p = .804					
Kappa	.320					

				PROFILE GH-2 N	PROFILE GH-2 Y	Total
24	ORL	**N**	Count	19,612	176	19,788
		Y	Count	169	**113**	**282**
			% within PROFILE GH-2	0.9%	**39.1%**	1.4%
	Total	=	Count	19,781	**289**	20,070
Exact Significance	p = .747					
Kappa	.387					

				PROFILE GH-2 N	PROFILE GH-2 Y	Total
29	ORL	**N**	Count	22,127	182	22,309
		Y	Count	229	**115**	**344**
			% within PROFILE GH-2	1.0%	**38.7%**	1.5%
	Total	=	Count	22,356	**297**	22,653
Exact Significance	p = .023					
Kappa	.350					

				PROFILE GH-2 N	PROFILE GH-2 Y	Total
34	ORL	**N**	Count	16,095	204	16,299
		Y	Count	419	**170**	**589**
			% within PROFILE GH-2	2.5%	**45.5%**	3.5%
	Total	=	Count	16,514	**374**	16,888
Exact Significance	p <.001					
Kappa	.335					

				PROFILE GH-2 N	PROFILE GH-2 Y	Total
39	ORL	**N**	Count	11,863	199	12,062
		Y	Count	558	**255**	**813**
			% within PROFILE GH-2	4.5%	**56.7%**	6.3%
	Total	=	Count	12,421	**454**	12,875
Exact Significance	p <.001					
Kappa	.374					

				PROFILE GH-2 N	PROFILE GH-2 Y	Total
40	ORL	**N**	Count	8,251	342	8,593
		Y	Count	560	**363**	**923**
			% within PROFILE GH-2	6.4%	**51.5%**	9.7%
	Total	=	Count	8,811	**705**	9,516
Exact Significance	p <.001					
Kappa	.395					

ORL * PROFILE GH-2 * GENDER * AGE Table

AGE GROUP	GENDER				PROFILE GH-2 N	PROFILE GH-2 Y	Total
20	**F**	**ORL**	**N**	Count	93	2	95
			Y	Count	1	**0**	**1**
				% within PROFILE GH-2	1.1%	**0.0%**	**1.0%**
		Total	=	Count	94	**2**	96
	M	**ORL**	**N**	Count	500	7	507
			Y	Count	6	**4**	**10**
				% within PROFILE GH-2	1.2%	**36.4%**	1.9%
		Total	=	Count	506	**11**	517

					N	Y	Total
24	**F**	**ORL**	**N**	Count	2,375	5	2,380
			Y	Count	12	**10**	**22**
				% within PROFILE GH-2	0.5%	**66.7%**	0.9%
		Total	=	Count	2,387	**15**	2,402
	M	**ORL**	**N**	Count	17,237	171	17,408
			Y	Count	157	**103**	**260**
				% within PROFILE GH-2	0.9%	**37.6%**	1.5%
		Total	=	Count	17,394	**274**	17,668

					N	Y	Total
29	**F**	**ORL**	**N**	Count	2,463	9	2,472
			Y	Count	10	**7**	**17**
				% within PROFILE GH-2	0.4%	**43.8%**	0.7%
		Total	=	Count	2,473	**16**	2,489
	M	**ORL**	**N**	Count	19,664	173	19,837
			Y	Count	219	**108**	**327**
				% within PROFILE GH-2	1.1%	**38.4%**	1.6%
		Total	=	Count	19,883	**281**	20,164

					N	Y	Total
34	**F**	**ORL**	**N**	Count	1,541	5	1,546
			Y	Count	23	**5**	**28**
				% within PROFILE GH-2	1.5%	**50.0%**	1.8%
		Total	=	Count	1,564	**10**	1,574
	M	**ORL**	**N**	Count	14,554	199	14,753
			Y	Count	396	**165**	**561**
				% within PROFILE GH-2	2.6%	**45.3%**	3.7%
		Total	=	Count	14,950	**364**	15,314

ORL * PROFILE GH-2 * GENDER * AGE Table

AGE GROUP	GENDER				PROFILE GH-2 N	PROFILE GH-2 Y	Total
39	**F**	**ORL**	**N**	Count	1,122	7	1,129
			Y	Count	14	**8**	**22**
				% within PROFILE GH-2	1.2%	**53.3%**	1.9%
		Total	=	Count	1,136	**15**	1,151
	M	**ORL**	**N**	Count	10,741	192	10,933
			Y	Count	544	**247**	**791**
				% within PROFILE GH-2	4.8%	**56.3%**	6.7%
		Total	=	Count	11,285	**439**	11,724
					N	**Y**	Total
40	**F**	**ORL**	**N**	Count	791	8	799
			Y	Count	13	**6**	**19**
				% within PROFILE GH-2	1.6%	**42.9%**	2.3%
		Total	=	Count	804	**14**	818
	M	**ORL**	**N**	Count	7,460	334	7,794
			Y	Count	547	**357**	**904**
				% within PROFILE GH-2	6.8%	**51.7%**	10.4%
		Total	=	Count	8,007	**691**	8,698

ORL * PROFILE GH-2 * GENDER * AGE Table

AGE GROUP	GENDER		Value	**Exact Significance (2-sided)**
20	F	McNemar Test		**1.000** [a]
		N of Valid Cases	96	
	M	McNemar Test		**1.000** [a]
		N of Valid Cases	517	
24	F	McNemar Test		**0.143** [a]
		N of Valid Cases	2402	
	M	McNemar Test		**0.473** [a]
		N of Valid Cases	17668	
29	F	McNemar Test		**1.000** [a]
		N of Valid Cases	2489	
	M	McNemar Test		**0.023** [a]
		N of Valid Cases	20164	
34	F	McNemar Test		**0.001** [a]
		N of Valid Cases	1574	
	M	McNemar Test		**0.000** [a]
		N of Valid Cases	15314	
39	F	McNemar Test		**0.189** [a]
		N of Valid Cases	1151	
	M	McNemar Test		**0.000** [a]
		N of Valid Cases	11724	
40	F	McNemar Test		**0.383** [a]
		N of Valid Cases	818	
	M	McNemar Test		**0.000** [a]
		N of Valid Cases	8698	

a Binomial distribution used.

ORL * PROFILE GH-2 * GENDER * AGE Table

AGE GROUP	Gender			Value
20	F	Measure of Agreement	**Kappa**	**-0.014**
		N of Valid Cases		96
	M	Measure of Agreement	**Kappa**	**0.368**
		N of Valid Cases		517
24	F	Measure of Agreement	**Kappa**	**0.537**
		N of Valid Cases		2402
	M	Measure of Agreement	**Kappa**	**0.376**
		N of Valid Cases		17668
29	F	Measure of Agreement	**Kappa**	**0.420**
		N of Valid Cases		2489
	M	Measure of Agreement	**Kappa**	**0.345**
		N of Valid Cases		20164
34	F	Measure of Agreement	**Kappa**	**0.256**
		N of Valid Cases		1574
	M	Measure of Agreement	**Kappa**	**0.338**
		N of Valid Cases		15314
39	F	Measure of Agreement	**Kappa**	**0.423**
		N of Valid Cases		1151
	M	Measure of Agreement	**Kappa**	**0.371**
		N of Valid Cases		11724
40	F	Measure of Agreement	**Kappa**	**0.351**
		N of Valid Cases		818
	M	Measure of Agreement	**Kappa**	**0.393**
		N of Valid Cases		8698